

The accompanying table exhibits a compilation of the data on these principles. At the end of each year the average for the six cold and six warm months has been computed, and there is added here a summary of the four years.

Year.	Highs.					Lows.				
	Mean first seen.		Mean last seen.		Velocity.	Mean first seen.		Mean last seen.		Velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		Lat. N.	Long. W.	Lat. N.	Long. W.	
	°	°	°	°		°	°	°	°	
1895	47	110	39	86	24	45	107	45	73	26
1896	48	111	42	75	24	45	111	46	74	26
1897	48	113	38	73	24	46	110	46	71	26
1898	46	114	40	72	25	45	111	46	67	26
Mean ..	47	112	40	76	24	46	110	46	71	26

Mean velocity by cold and warm months is as follows:

Year.	Mean velocity.			
	Highs.		Lows.	
	Cold.	Warm.	Cold.	Warm.
	Miles.	Miles.	Miles.	Miles.
1895.....	27	22	30	23
1896.....	25	23	28	24
1897.....	25	22	29	23
1898.....	26	23	29	23
Mean.....	26	23	29	24

The average velocity of the highs and lows through the four years was remarkably uniform, 24 and 26 miles an hour, respectively. We also see, as is well known, that the velocity during the cold months is greater than during the warm season. On comparing the velocity of the highs with that of the lows during the cold and warm months, we see a uniform greater velocity of lows than of highs in the cold season, but during the warm season the velocity is practically the same. This may be an important point in the study of these conditions.—H. A. Hazen, Professor.

RIVER AND FLOOD SERVICE.

By H. C. FRANKENFIELD.

Heights of rivers above zeros of gauges, 1898.

Stations.	Highest water.		Lowest water.		Mean stage.	Annual range.
	Stage.	Date.	Stage.	Date.		
<i>Mississippi River.</i>	Feet.		Feet.		Feet.	Feet.
St. Paul, Minn.....	10.7	June 8, 9.....	2.7	Aug. 15, 20.....	3.7	8.0
Reeds Landing, Minn.....	9.0	June 11.....	—0.9	Sept. 8-10.....	6.5	9.9
La Crosse, Wis.....	9.9	June 15.....	1.3	Sept. 15, 16, 27-29	3.6	8.6
North McGregor, Iowa.....	10.0	June 19, 20.....	0.1	Nov. 26.....	8.5	9.9
Dubuque, Iowa.....	9.4	June 21-23.....	0.5	Sept. 30.....	8.6	8.9
Leclaire, Iowa.....	6.0	June 24-27.....	0.4	Oct. 1-10.....	2.4	5.6
Davenport, Iowa.....	7.4	Mar. 14.....	0.8	Sept. 30.....	3.4	6.6
Galland, Iowa.....	4.4	June 27.....	0.4	Oct. 1-11.....	1.9	4.0
Keokuk, Iowa.....	9.8	Feb. 13.....	—2.0	Oct. 6-12, 14-16.....	3.0	11.8
Hannibal, Mo.....	11.7	May 21.....	—0.6	Dec. 6.....	4.0	12.3
Grafton, Ill.....	18.1	May 23.....	1.9	Dec. 9, 10.....	7.4	16.2
St. Louis, Mo.....	27.2	May 23.....	0.3	Dec. 11.....	11.4	26.9
Chester, Ill.....	22.2	May 24.....	—0.5	Dec. 14.....	8.5	22.7
Cairo, Ill.....	49.8	Apr. 6.....	7.6	Oct. 10.....	23.7	42.2
Memphis, Tenn.....	37.3	Apr. 11, 12.....	5.1	Oct. 10, 23, 24.....	16.0	32.2
Helena, Ark.....	49.1	Apr. 17.....	7.7	Oct. 18.....	23.0	41.4
Arkansas City, Ark.....	51.2	Apr. 19-21.....	9.5	Sept. 12, 13.....	26.3	41.7
Greenville, Miss.....	46.2	Apr. 21.....	7.2	Jan. 13.....	21.8	39.0
Vicksburg, Miss.....	49.4	Apr. 24, 25.....	7.9	Jan. 1.....	24.9	41.5
New Orleans, La.....	17.0	May 1.....	2.8	Jan. 3.....	6.8	14.2
<i>Arkansas River.</i>						
Wichita, Kans.....	5.6	June 10.....	0.6	Jan. 8-11.....	1.9	5.0
Fort Smith, Ark.....	35.0	May 7.....	1.0	Jan. 11, 12.....	7.4	34.0
Dardanelle, Ark.....	29.3	May 10.....	0.2	Jan. 12.....	7.4	29.1
Little Rock, Ark.....	27.2	May 11.....	2.9	Jan. 5.....	9.3	24.3

Heights of rivers above zeros of gauges, 1898—Continued.

Stations.	Highest water.		Lowest water.		Mean stage.	Annual range.
	Stage.	Date.	Stage.	Date.		
<i>White River.</i>	Feet.		Feet.		Feet.	Feet.
Newport, Ark.....	32.1	May 6.....	2.1	Jan. 10.....	10.7	30.0
<i>Des Moines River.</i>						
Des Moines, Iowa.....	8.6	June 11.....	2.3	Dec. 22, 23, 25-28.	3.1	6.4
<i>Illinois River.</i>						
Peoria, Ill.....	19.3	Mar. 31.....	3.5	July 24.....	8.6	15.8
<i>Missouri River.</i>						
Bismarck, N. Dak.....	12.6	June 26.....	2.0	Oct. 2-8.....	5.1	10.6
Pierre, S. Dak.....	11.2	June 28.....	0.8	Mar. 24.....	3.2	10.4
Sioux City, Iowa.....	14.7	June 30.....	5.0	Oct. 16, 18.....	7.8	9.7
Omaha, Nebr.....	14.7	July 1, 2.....	5.3	Mar. 6, 7.....	8.7	9.4
St. Joseph, Mo.....	10.2	July 4.....	—3.1	Dec. 9.....	3.6	13.3
Kansas City, Mo.....	21.5	June 12.....	4.0	Dec. 12.....	9.3	17.5
Boonville, Mo.....	19.3	June 15.....	1.7	Dec. 14.....	8.6	17.6
Hermann, Mo.....	18.8	June 17.....	2.1	Dec. 13.....	9.4	16.7
<i>Ohio River.</i>						
Pittsburg, Pa.....	28.5	Mar. 24.....	2.2	Dec. 12, 16, 17.....	7.1	26.3
Davis Island Dam, Pa.....	27.1	Mar. 24.....	2.0	July 17, Sept. 21	7.1	25.1
Wheeling, W. Va.....	43.9	Mar. 24.....	1.5	Sept. 28, 29.....	9.3	42.4
Parkersburg, W. Va.....	47.8	Mar. 26.....	2.3	Oct. 7.....	10.9	45.5
Point Pleasant, W. Va.....	51.2	Mar. 27.....	1.7	Sept. 22-24.....	12.5	49.5
Catlettsburg, Ky.....	56.0	Mar. 27, 28.....	1.0	Oct. 3.....	15.6	55.0
Portsmouth, Ohio.....	57.3	Mar. 28.....	2.9	Sept. 24, Oct. 3, 4	17.1	54.4
Cincinnati, Ohio.....	61.4	Mar. 29.....	4.5	Oct. 6.....	19.7	56.9
Louisville, Ky.....	36.0	Mar. 30.....	3.5	Oct. 8.....	9.4	32.5
Evansville, Ind.....	44.8	Apr. 2, 3.....	4.1	Sept. 30, Oct. 8.....	16.5	40.7
Paducah, Ky.....	47.3	Apr. 6.....	3.5	Sept. 22.....	16.5	43.8
<i>Alleghany River.</i>						
Warren, Pa.....	8.2	Feb. 13.....	0.0	2.3	8.2
Oil City, Pa.....	10.2	Feb. 13.....	0.4	Oct. 4-6.....	2.9	9.8
Parkers Landing, Pa.....	14.0	Mar. 24.....	0.8	July 23, 24.....	3.2	13.7
Freeport, Pa.....	25.3	Mar. 24.....	0.8	July 18, 19.....	5.6	24.5
<i>Conemaugh River.</i>						
Johnstown, Pa.....	9.0	Oct. 22.....	0.8	July 17.....	2.8	8.2
<i>Red Bank Creek.</i>						
Brookville, Pa.....	10.5	Mar. 23.....	0.1	June 8-12.....	1.0	10.4
<i>Beaver River.</i>						
Ellwood Junction, Pa.....	13.2	Mar. 23.....	—1.5	July 24.....	1.9	14.7
<i>Cumberland River.</i>						
Burnside, Ky.....	32.6	Jan. 23.....	—0.1	July 4, 15.....	5.3	32.7
Carthage, Tenn.....	34.1	Jan. 25.....	0.8	July 16-19.....	6.4	33.3
Nashville, Tenn.....	38.8	Jan. 23.....	1.5	July 4.....	9.1	37.3
<i>Great Kanawha River.</i>						
Charleston, W. Va.....	31.0	Aug. 11.....	3.0	Feb. 4-6.....	7.0	28.0
<i>New River.</i>						
Hinton, W. Va.....	9.0	Aug. 11.....	1.0	July 14.....	2.6	8.0
<i>Licking River.</i>						
Falmouth, Ky.....	27.5	Jan. 23.....	0.9	Oct. 1-4.....	3.7	26.6
<i>Monongahela River.</i>						
Weston, W. Va.....	13.1	Mar. 20.....	—1.5	Mar. 12, 13.....	1.0	14.6
Fairmont, W. Va.....	18.4	Mar. 25.....	—0.3	June 9, 10.....	2.9	18.7
Greensboro, Pa.....	21.2	Mar. 25.....	6.3	July 15, 16, 17, 19	8.9	14.9
Lock No. 4, Pa.....	23.9	Mar. 30.....	5.6	Sept. 22-23.....	9.7	18.3
<i>Cheat River.</i>						
Rowlesburg, W. Va.....	9.4	Aug. 11.....	0.5	Sept. 24, 25.....	3.3	8.9
<i>Youghiogheny River.</i>						
Confluence, Pa.....	8.1	Mar. 25.....	0.5	Oct. 3, 4.....	2.7	7.6
West Newton, Pa.....	10.9	Mar. 24.....	—0.2	Nov. 5.....	2.2	11.1
<i>Muskingum River.</i>						
Zanesville, Ohio.....	35.9	Mar. 24.....	6.0	July 7-10.....	10.0	39.9
<i>Tennessee River.</i>						
Kingston, Tenn.....	13.0	Sept. 4.....	0.2	June 14-16.....	2.9	12.8
Chattanooga, Tenn.....	24.6	Sept. 5.....	1.6	June 15.....	15.8	23.0
Bridgeport, Ala.....	18.2	Sept. 6.....	0.6	June 12, 15, 16.....	4.2	17.6
Florence, Ala.....	13.8	Jan. 28, 29.....	0.5	June 14.....	4.1	13.3
Johnsonville, Tenn.....	29.1	Jan. 24.....	1.0	Oct. 3-5.....	6.5	28.1
<i>Clinch River.</i>						
Spears Ferry, Va.....	10.8	Aug. 11.....	—0.6	Oct. 2.....	1.0	11.4
Clinton, Tenn.....	21.0	Aug. 12.....	2.4	Oct. 4.....	6.1	18.6
<i>Wabash River.</i>						
Mount Carmel, Ill.....	27.0	Mar. 30, 31.....	1.3	Sept. 4, 5.....	7.6	25.7
<i>Red River.</i>						
Arthur City, Tex.....	21.1	May 8.....	3.0	Feb. 4, 5.....	6.6	18.1
Fulton, Ark.....	27.9	May 11.....	2.5	Jan. 11.....	8.2	25.4
Shreveport, La.....	14.9	May 21.....	—0.1	Nov. 9.....	6.4	15.0
Alexandria, La.....	16.9	Feb. 1.....	—1.0	Nov. 9.....	7.0	17.9
<i>Atchafalaya River.</i>						
Melville, La.....	33.9	Apr. 29, 30.....	9.5	Sept. 18.....	22.8	24.4
<i>Ouachita River.</i>						
Camden, Ark.....	33.7	Jan. 25.....	3.2	Sept. 12-14.....	6.7	30.5
Monroe, La.....	35.9	Feb. 12, 13.....	0.8	Sept. 13-15.....	14.4	25.1
<i>Yazoo River.</i>						
Yazoo, Miss.....	24.4	Apr. 25-28.....	—1.0	Nov. 9, 10.....	9.9	25.4
<i>Flint River.</i>						
Albany, Ga.....	17.2	Sept. 2.....	0.5	June 7-10.....	4.4	16.7
<i>Cape Fear River.</i>						
Fayetteville, N. C.....	29.2	Aug. 22.....	1.0	July 5.....	6.1	28.2
<i>Columbia River.</i>						
Umatilla, Oreg.....	21.8	June 17, 18.....	—0.7	Mar. 31.....	7.9	22.5
The Dalles, Oreg.....	36.9	June 20, 21.....	—0.8	Dec. 17, 18.....	12.7	37.7
<i>Willamette River.</i>						
Albany, Oreg.....	16.4	Nov. 20.....	0.7	Aug. 20-31.....	5.4	15.7
Portland, Oreg.....	20.7	June 19-21.....	0.7	Sept. 1-19.....	7.8	20.0
<i>Edisto River.</i>						
Edisto, S. C.....	5.9	Sept. 12, 13.....	0.4	June 13-16.....	3.4	5.5

Heights of rivers above zeros of gauges, 1898—Continued.

Stations.	Highest water.		Lowest water.		Mean stage.	Annual range.
	Stage.	Date.	Stage.	Date.		
<i>James River.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Lynchburg, Va.	12.0	Oct. 22	—0.2	Sept. 18, 21, 22 ...	1.6	12.2
Richmond, Va.	11.7	Oct. 21	—0.2	July 5, 14-17 ...	1.0	11.9
<i>Alabama River.</i>				Sept. 14-18, 23 ...		
Montgomery, Ala.	28.0	Oct. 10	—0.8	June 13 5.0	28.8	
Selma, Ala.	28.5	Oct. 11	—1.3	June 12, 14, 15 ...	29.8	
<i>Coosa River.</i>						
Rome, Ga.	24.3	Sept. 4	2.0	July 2-5 3.7	22.3	
Gadsden, Ala.	22.0	Oct. 8	—0.3	July 5-8 4.8	22.3	
<i>Tombigbee River.</i>						
Columbus, Miss.	21.5	Jan. 25	—3.7	Sept. 19, 20 5.4	25.2	
Demopolis, Ala.	46.0	Feb. 1 3.0	—3.0	Sept. 20, 21 8.5	49.0	
<i>Black Warrior River.</i>						
Tuscaloosa, Ala.	43.5	Jan. 27	—1.0	Oct. 5 6.4	44.5	
<i>Pedee River.</i>						
Cheraw, S. C.	29.5	Aug. 22	0.4	July 5 3.7	29.1	
<i>Black River.</i>						
Kingstree, S. C.	10.7	Nov. 30	0.2	June 18 4.8	10.5	
<i>Lumber River.</i>						
Fairbluff, N. C.	5.2	Sept. 3-7 ...	—0.9	June 19-18 2.4	6.1	
<i>Lynch Creek.</i>						
Effingham, S. C.	18.8	Nov. 26. ...	1.7	June 16, 17 5.6	12.1	
<i>Potomac River.</i>						
Harpers Ferry, W. Va.	15.5	Aug. 12 0.4	0.4	July 19-21 3.0	15.1	

Heights of rivers above zeros of gauges, 1898—Continued.

Stations.	Highest water.		Lowest water.		Mean stage.	Annual range.
	Stage.	Date.	Stage.	Date.		
<i>Roanoke River.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Clarksville, Va.	10.4	Sept. 25	0.0	July 4, 5 1.4	10.4	
<i>Sacramento River.</i>				Sept. 19-22 ...		
Red Bluff, Cal.	12.0	Feb. 29	—0.8	Aug. 28-31 1.6	12.8	
Sacramento, Cal.	16.7	Mar. 10	7.1	Sept. 1-14 10.0	9.6	
<i>Santee River.</i>				Sept. 18-21 ...		
St. Stephens, S. C.	8.7	Sept. 3-7	—2.0	June 15, 16 3.8	10.7	
<i>Congaree River.</i>						
Columbia, S. C.	15.8	Aug. 28	—0.9	May 25, 26 2.1	16.7	
<i>Wateree River.</i>						
Camden, S. C.	25.2	Oct. 7 0.9	0.9	July 5 6.6	24.3	
<i>Savannah River.</i>						
Augusta, Ga.	28.4	Sept. 2, 3	3.8	July 6 8.9	25.1	
<i>Susquehanna River.</i>						
Wilkesbarre, Pa.	17.9	Jan. 16	—0.4	July 18-30 4.2	18.3	
Harrisburg, Pa.	15.2	Mar. 24, 25 ..	0.7	July 18, 19 3.9	14.5	
<i>Juniata River.</i>				Oct. 8-7 4.8	7.5	
Huntingdon, Pa.	10.2	Mar. 23 2.7	2.7	Oct. 17, 18 3.3	20.6	
<i>W. Br. of Susquehanna.</i>						
Williamsport, Pa.	21.0	Mar. 24 0.4	0.4	Sept. 19, 21, 22-25		
<i>Waccamaw River.</i>						
Conway, S. C.	5.6	Dec. 13, 14 ..	0.1	June 16 2.5	5.5	

* July 24-27, Sept. 25-30, Oct. 1-21.

GENERAL CLIMATIC CONDITIONS.

By ALFRED J. HENRY, Chief of Division of Records and Meteorological Data.

ATMOSPHERIC PRESSURE.

The mean pressure for 1898 is shown numerically in Tables I and II. The method of reduction to sea level and the omission of the gravity correction, as explained by Professor H. A. Hazen, in the MONTHLY WEATHER REVIEW for 1894, Vol. XXII, page 538, have continued in use during the year and the figures given in Tables I and II are the mean pressures obtained by the use of Professor Hazen's method of reduction.

In conformity with the practice of former years the observed mean pressures have also been reduced to standard gravity and to sea level by the tables and methods of the International Meteorological Committee, as explained in the MONTHLY WEATHER REVIEW for 1895, Vol. XXIII, pages 492-494. The results obtained by the last method are shown in Table III and on Chart I. The data in the last column of Table III are the pressures at 10,000 feet above sea level, obtained by assuming a uniform decrement of temperature at the rate of 2° F. per 1,000 feet (0.37° C. per 100 meters) as in former Annual Summaries; the resulting isobars are shown on Chart II.

The distribution of mean pressure at sea level, as shown by Chart I, does not differ appreciably from that of former years. The Plateau High is perhaps a little farther to the northwestward and nearer the coast than during previous years, and the Arizona Low is a little deeper than usual, and extends farther to the northwestward into California. The trough of low pressure extending from the lower Rio Grande Valley into the British Possessions is rather well marked. East of the Mississippi River the distribution agrees closely with that of former years.

The high-level pressures on Chart II do not differ appreciably from those of former years. The high-level gradients, it will be seen, are much steeper than those at sea level, particularly east of the Rocky Mountains. West of the mountains, however, and particularly on the Pacific coast, the high-level gradients appear to have been weaker than usual. We are disposed to associate the pressure distribution on the Pacific coast with the remarkable drought that has existed in that locality for more than a year past. The extension of the

Plateau high to the northwestward over eastern Oregon and northeastern Washington already noticed, is generally coincident with a shifting to the northward of the atmospheric disturbances which ordinarily strike the coast of Washington and Oregon and move eastward between latitude 45° and 50°. The deepening of the trough of low pressure that parallels the eastern foothills of the Rocky Mountains would seem to indicate a movement of low area storms southeastward from the Northwest Territories. The fact that precipitation was above normal generally throughout the greater part of the eastern foothills and plains, seems to lend confirmation to the belief that the cause of drought on the Pacific coast must be looked for in the changes or modifications of the general air movements over the Rocky Mountain and Plateau regions. Such changed or modified motion must necessarily produce variations in rainfall distribution, temperature, and other weather conditions, but the problem is as yet obscure.

TEMPERATURE.

The year opened with high temperature for the season east of the Rocky Mountains and cold weather in the Plateau region and on the middle and south Pacific coasts. The mild temperatures east of the Rocky Mountains continued throughout February and March, the winter being unusually mild, especially in North Dakota, the Lake region, and the Missouri and upper Mississippi valleys.

Interlake navigation opened much earlier than usual. The Straits of Mackinac were free from ice on March 28, the earliest date but one during the sixty-three years that records have been kept. While navigation opened much earlier than usual its close was marked by one of the greatest ice blockades at the west end of Lake Erie in the history of lake navigation. The cold weather during the early part of December froze the water in sheltered bays to a depth of 6 to 8 inches. Great fields of ice formed in the highway of vessels between the mouth of the Detroit River and points to the eastward, in which a fleet of nearly one hundred vessels was soon imprisoned. The vessels were held in the ice jam about ten